EVALUATION OF THE NEWBORN INFANT—SECOND REPORT

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The condition of each newborn infant was expressed by a score, the sum of five numbers obtained within 60 seconds after complete birth. The numbers were determined by objective observations of heart rate, promptness and vigor of the first respiratory efforts, and reflex response to certain stimuli, muscle tone, and color. The highest possible score was 10, representing the optimum condition of the infant. The predictive value of such scores is here established by a study of the scores of 15,348 infants, for the death rate among infants scoring 2, 1, or 0 was 15%, while that for infants scoring 10 was 0.13%. The score was found to be a measure of the relative handicaps suffered by infants born prematurely, delivered spontaneously at term, delivered by cesarean section, or subjected to other obstetrical and anesthetic hazards. The lower scores were generally associated with chemical findings characteristic of asphyxia in the blood obtained by umbilical catheterization. The score was especially useful in judging the need for resuscitative measures, such as respiratory assistance.

In 1952, a scoring system was devised to evaluate the condition of infants born at the Sloane Hospital for Women.[1] Its use has increased yearly in various clinics. This report will discuss the incidence of the scores of 15,348 infants, the corresponding death rates, the relation to biochemical studies, and considerations for improving the system. The adoption of this method by the Collaborative Study of Cerebral Palsy has resulted in valuable criticism from other clinics using it for the first time.

The incidence of scores, in all types of deliveries, does not vary significantly from that found in two previous reviews[2] (fig. 1, *top*). Approximately 6% of the infants were severely depressed, 24% moderately so, and 70% were in excellent condition. The incidence in the three major types of deliveries, vaginal vertex, cesarean section, and breech, varies greatly (fig. 2). Over 20% of infants delivered by breech presentation fall in the severely depressed group, while only 12% of those by cesarean section and 3% of those by vaginal vertex delivery score 0, 1, or 2.

The over-all death rates were the same as with a smaller number of patients (fig. 1, *bottom*); 15% of groups 0, 1, and 2 died. When subdivided according to type of delivery (vaginal vertex, 1.4%; cesarean section, 3.8%; breech, 13.3%), breech deliveries showed the highest mortality (fig. 3). This is directly related to prematurity. While 35% of the infants delivered by breech presentation at Sloane

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Hospital were between 500 and 2,500 Gm. (1 to 5.5 lb.), 90% of the deaths were in premature infants.

Since the majority of neonatal deaths occur in premature infants, it was thought wise to examine the scoring system with special emphasis on this group. The following graphs show that the incidence and the death rates of the various scores follow a pattern similar to the entire group (fig. 4).

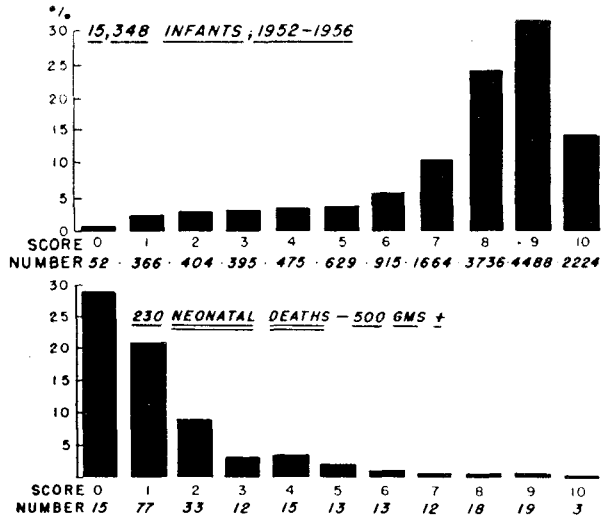

Fig. 1.—Distribution of scores in evaluation of newborn infants in all types of deliveries (*top*) and in evaluation of newborn infants and neonatal deaths in vaginal vertex delivery and cesarean section (*bottom*).

The scoring system has been used as a guide to the need for resuscitation. Since the death rates dropped quite sharply after a score of 4 in the preliminary study, we have used a score of 4 or less as an indication to assist ventilation. During the past two years, we have had an opportunity to check this clinical impression with biochemical studies immediately after birth and can relate the findings to the score.[3] Since the arterial blood of one-quarter of the vigorous infants was 10% saturated or less, it soon became evident that oxygen values alone had no relation to the clinical condition of the infant. However, no infant with good oxygen values in his arterial blood was depressed. If, in addition to hypoxia at birth, an elevated tension of carbon dioxide, a low pH, and low buffer base value existed, the infant was severely depressed.

After using umbilical arterial samples as a better reflection of the infant's condition than umbilical vein blood, it was decided that blood obtained from inside the baby by umbilical catheterization gave the truest values. The methods used have been reported previously [3] and detailed chemical findings are the subject of another communication. In summary, in almost every instance the pCO_2 in the aorta was higher than in the umbilical artery. Likewise, the pH and the buffer base values were lower in blood taken from within the infant. All these findings point to the rapid development of respiratory and metabolic acidosis during and immediately after birth.[4] Whether or not these conditions are detrimental to mental and metabolic development remains to be proved, but they can hardly be desirable. The findings stress the importance of prompt treatment by the simple process of ventilation. Intentional delay during the course of delivery is not to be condoned.

With a few exceptions, the more asphyxic the blood values, the lower the score one minute after birth. Using the buffer base value as the measure of the duration of asphyxia, the value in infants with scores of 4 and lower was 29.3 mEq. per liter, while those with scores of 8, 9, and 10 were 36.6 mEq. per liter. This is statistically significant ($p < 0.001$) (fig. 5).

The exceptions remain to be explained and in general are related to the type of anesthesia and medication administered. It has been shown previously that the babies born after use of regional

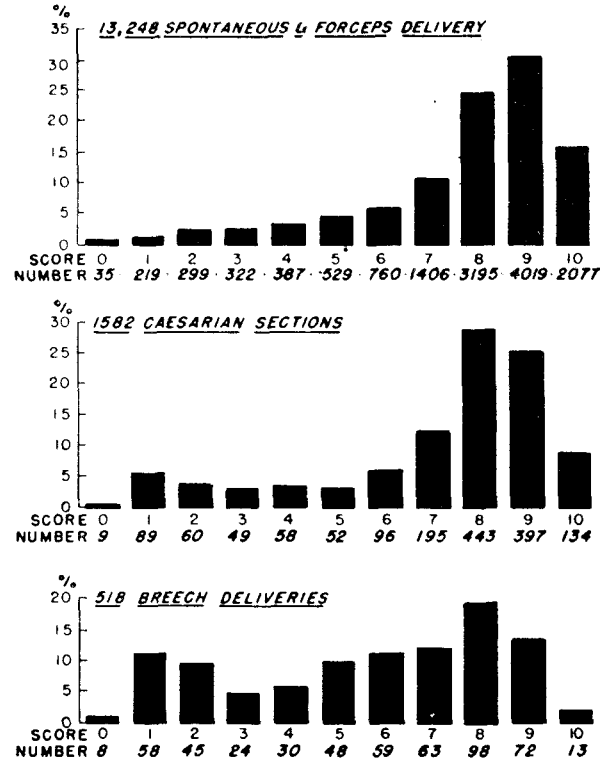

Fig. 2.—Incidence of scores in evaluation of newborn infants in three major types of deliveries.

anesthesia in the mother are more vigorous than after a general anesthesia, though skillfully administered.[5] The explanation probably depends on the action of general anesthetic agents in the presence of asphyxia. The drugs used for regional anesthesia may pass through the placenta but do not appear to augment the asphyxic depression of the infant.

Three patients with scores of 2 or 3 showed buffer base values well above the average. All three mothers were given anesthetics by inhalation. It is likely that their low scores were due to reversible drug depression, rather than deranged acid-base balance.

Two other patients, with a score of 6, had buffer base values below the average for that score. One of these mothers received spinal anesthesia for delivery of a distressed infant with impacted shoulders. Eighteen minutes elapsed before sustained respiration. The other was a breech delivery of moderate difficulty, with cyclopropane as the anesthetic.

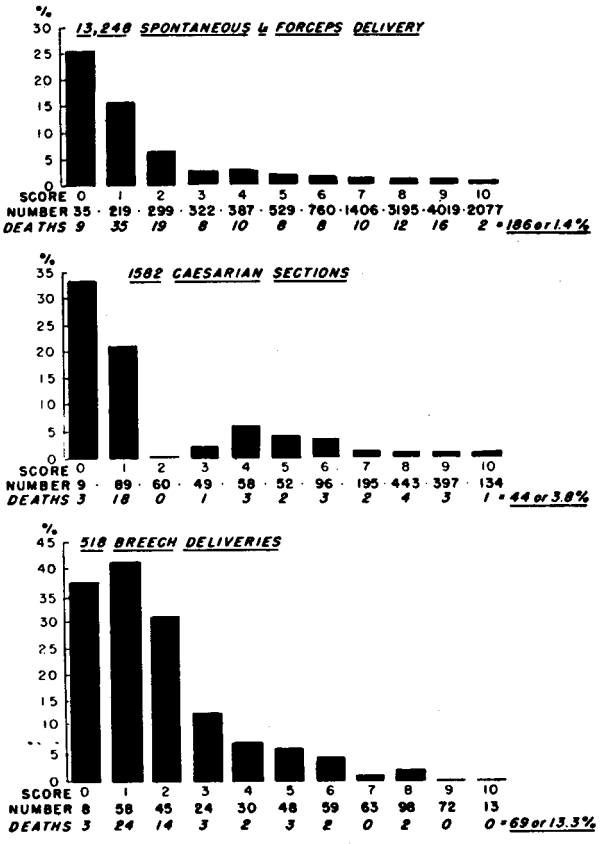

Fig. 3.—Incidence of scores in evaluation of newborn infants and neonatal deaths in three major types of delivery.

Practical Considerations in Using the Scoring System

After a year's trial with two individuals deciding on the score at various intervals after birth, it was decided that 60 seconds after the entire birth of the infant, irrespective of delivery of the placenta, represented the time of most severe depression after birth. In the Sloane Hospital the cord has been cut by this time, and the infant is in the hands of an individual other than the obstetrician. In many hospitals, such is not the case. Those obstetricians who practice slow delivery and delayed clamping of the cord until pulsations of the umbilical artery cease still have the infant in the sterile field. However, if the obstetrician is reminded of the passage of time by another observer, he may assign a score even though the cord is still attached. Two points

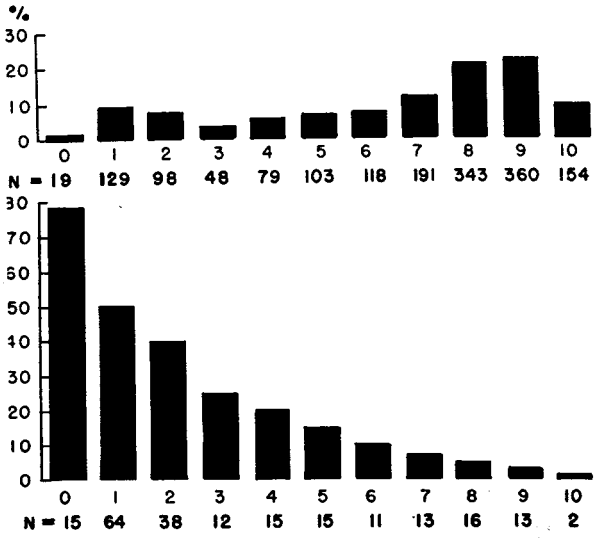

Fig. 4.—Distribution of scores in evaluation of 1,642 premature infants (*top*) and of 214 neonatal deaths in premature infants weighing 500 to 2,500 Gm. (1 to 5.5 lb.) (*bottom*).

are given for each of the following vital signs: color, respiration, muscular tone, nasal irritability, and heart rate. All infants with a score of 8, 9, or 10 are vigorous and have breathed within seconds of delivery. In this group, scores of 8 or 9 reflect

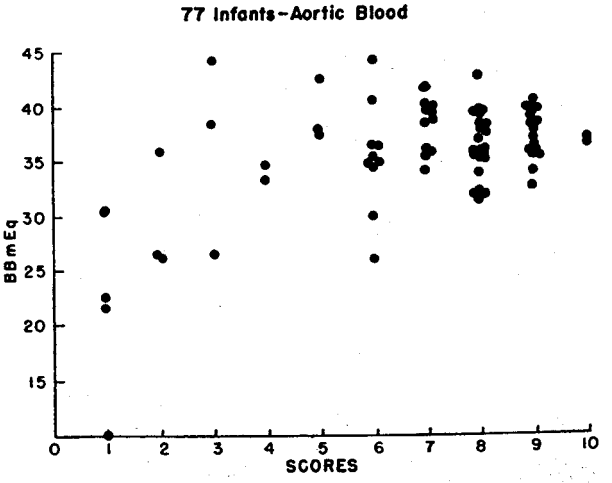

Fig. 5.—Relation of buffer base values to scores in evaluation of aortic blood from 77 newborn infants.

a lower score for color. The infants with a score of 4 or less are blue and limp and have failed to establish respiration by one minute. With increasing depression the last two vital signs, reflex irritability and heart rate, disappear in that order.

After six years of experience, the method has been found simple to teach to any personnel regularly in the delivery room, whether obstetricians, anesthesiologists, pediatricians, medical students, or graduate or student nurses. Whoever has the baby directly in his care at one minute can best assign the score. When two or more people decide independently, we find a range of one value above or below a decided score to be the widest variation. This occurs chiefly in the mildly depressed group, i. e., score 5, 6, 7. Variation is rare in infants with high or low scores. There is also less variation if the score is decided quickly.

In clinics where delayed clamping of the cord is routine, the test for reflex irritability with nasal catheter is not satisfactory. Also, when the infant is crying lustily, a sneeze may not be seen. A brisk tangential slap of the soles of the feet has been found to be a simpler and more effective method of testing this response. A cry is given a value of 2, a grimace or movement a value of 1, and no reaction, 0. Although the catheter may not be used to test reflex irritability, it is of value in the delivery room diagnosis to exclude atresia of the nose, esophagus, duodenum, jejunum, or rectum.

*Method of Scoring in Evaluation of Newborn Infant**

Sign	Score† 0	1	2
Heart rate	Absent	Slow (<100)	>100
Respiratory effort ..	Absent	Weak cry; hypoventilation	Good; strong cry
Muscle tone	Limp	Some flexion of extremities	Well flexed
Reflex irritability (response of skin stimulation to feet)	No response	Some motion	Cry
Color	Blue; pale	Body pink; extremities blue	Completely pink

* Evaluation 60 seconds after complete birth of infant (disregarding the cord and placenta).
† Score of 10 indicates infant in best possible condition.

All criteria are not of equal importance. With the introduction of the scoring system, it was felt that if each of the five criteria was weighted with a formula to give it proper significance, the system would become so complicated that it would not be used at all. Our first effort was to have the evaluation system used widely. Recently, after reports from individuals [6] and from advisory board of the National Institute of Neurological Diseases and Blindness as to the relative value of the five criteria, there is no doubt that the first two, heart rate and respiratory effort, are much more important than the next two, muscle tone and reflex irritability. Color is of the least importance. There is no objection whatsoever to revising the numerical situation to provide more accuracy, but deviations from the original scoring system should be clearly stated in such reports.

Muscle tone evaluation is performed visually. The tonus of a well-flexed infant is as obvious as the absence in a completely flaccid one. Anything in between receives a value of 1, rather than 2 or 0. With the recent fortunate increase in personnel in the delivery room, due to the National Institutes of Health program in 16 cooperating hospitals, objective measurements of muscle tone have been undertaken. To date, we are unfamiliar with the value of these detailed observations.

Serial scoring is of value. Although we have no statistics to prove the clinical impression as yet, it appears that the longer a low score stays low, the worse the prognosis for survival. If a score of 0, 1, 2 does not improve by 15 minutes, the prognosis is extremely grave. Only occasionally does a good score, such as 8, 9, 10, drop after one minute. This is almost always associated with enthusiastic efforts to aspirate the pharynx or to empty the stomach too soon. The cause is usually from the catheter tip touching the vocal cords, in a vigorous infant, and causing reflex laryngospasm. Other causes are respiratory obstruction or hypoventilation from drug depression. These complications are completely preventable.

A working plan for the scoring system is presented below. The only changes from the original chart are the omission of the word "irregular" to describe respiration and the new method for testing reflex irritability.

Summary

The incidence of scores and death rates in the evaluation of 15,348 newborn infants at the Sloane Hospital for Women varies in the three major types of deliveries: vaginal vertex, cesarean section, and breech presentation. This method of evaluation is useful in analyzing premature infants. Biochemical evidence corroborates the value of this scoring system. The infant is evaluated according to color, respiration, muscular tone, irritability, and heart rate.

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